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Li

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(54) **MEDICAL INSTRUMENTS FOR DIAPLASIS**

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A61B 17/88 (2006.01)

(52) **U.S. Cl.**
CPC *A61B 17/8866* (2013.01)

(58) **Field of Classification Search**
USPC .... 606/86 R, 90, 96, 99, 101, 106, 100; 81/27; 173/90, 91, 118, 202; 254/19; 433/150, 151
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,337,971	A	*	12/1943	Caviglia	433/151
2,437,014	A	*	3/1948	Arnesen et al.	606/100
3,702,028	A	*	11/1972	Edelman	433/150
4,476,861	A	*	10/1984	Dimakos et al.	606/100
5,584,839	A	*	12/1996	Gieringer	606/96
5,624,446	A	*	4/1997	Harryman, II	606/96
5,690,640	A	*	11/1997	Gotfried	606/105
6,349,618	B1	*	2/2002	Lowther	81/27
6,679,888	B2	*	1/2004	Green et al.	606/86 R
6,936,052	B2	*	8/2005	Gellman et al.	606/99
6,976,988	B2	*	12/2005	Ralph et al.	606/99
7,578,824	B2	*	8/2009	Justin et al.	606/96
8,486,084	B2	*	7/2013	Huene	606/100
2003/0083668	A1	*	5/2003	Rogers et al.	606/100
2006/0178673	A1	*	8/2006	Curran	606/100
2008/0071282	A1	*	3/2008	Assell et al.	606/92
2008/0200984	A1	*	8/2008	Jodaitis	A61F 2/442 623/17.16
2008/0208202	A1	*	8/2008	Williams	606/100
2009/0240256	A1	*	9/2009	Smith	606/100
2010/0256760	A1	*	10/2010	Hansell	623/17.11

FOREIGN PATENT DOCUMENTS

CN	2512392	9/2002
CN	2643845	9/2004
CN	2717396	8/2005
CN	201150563	11/2008
CN	101361672	2/2009

* cited by examiner

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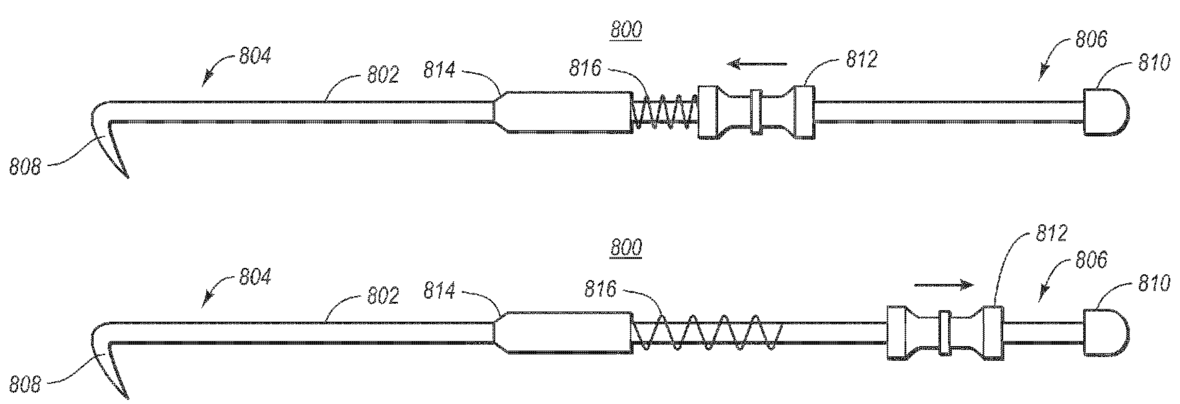
(57) **ABSTRACT**

A medical instrument includes a shaft and a movable element. The shaft has a first end having an engaging member. A second end of the shaft has a stopping member. The movable element is configured to move along the shaft. The medical instrument can be used to reduce a fracture. In use, this may include engaging a fractured bone segment with the engaging member and moving the movable element along the shaft towards the stopping member to create a force on the stopping member when the movable element comes in contact with the stopping member.

9 Claims, 6 Drawing Sheets



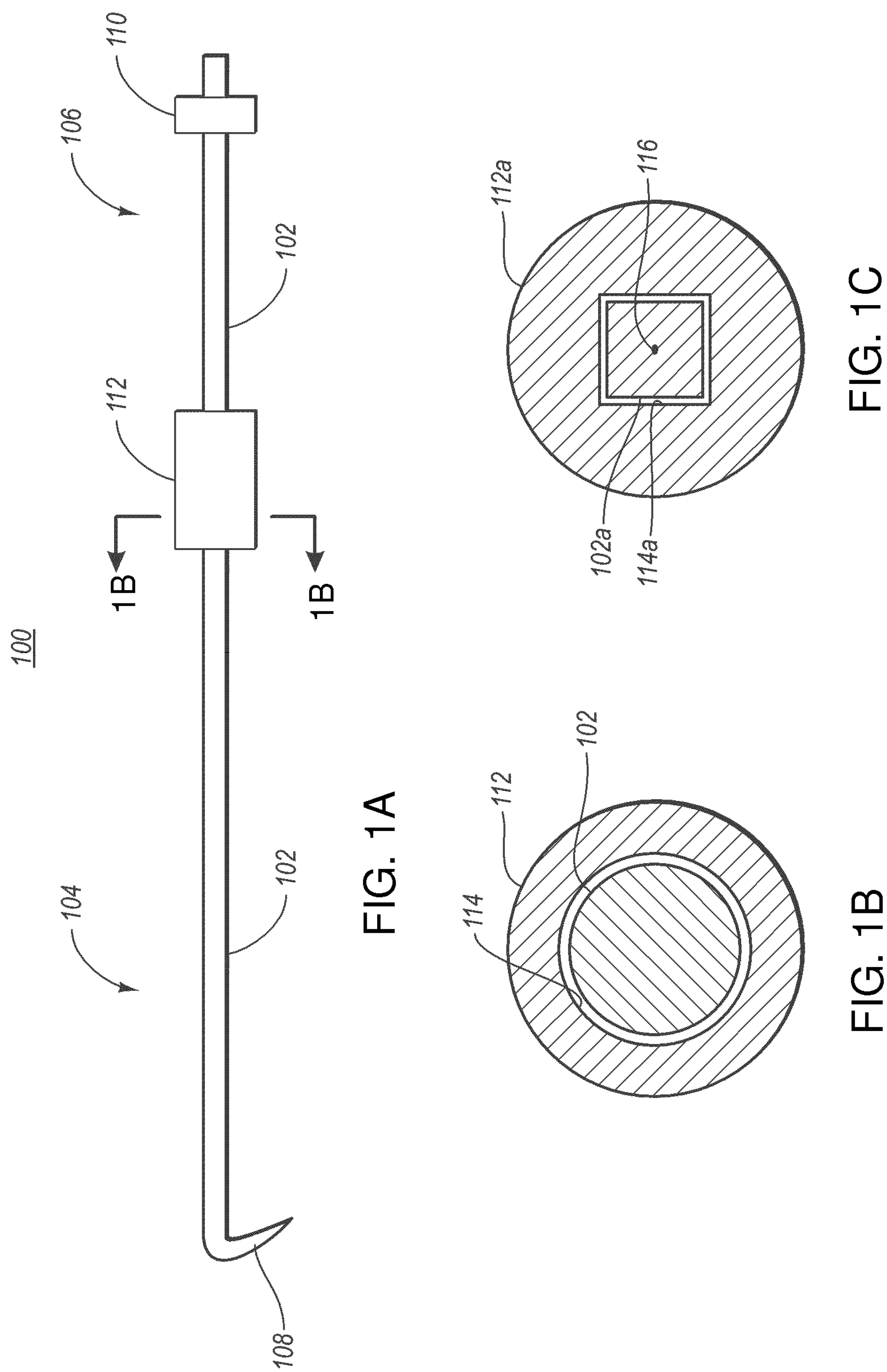
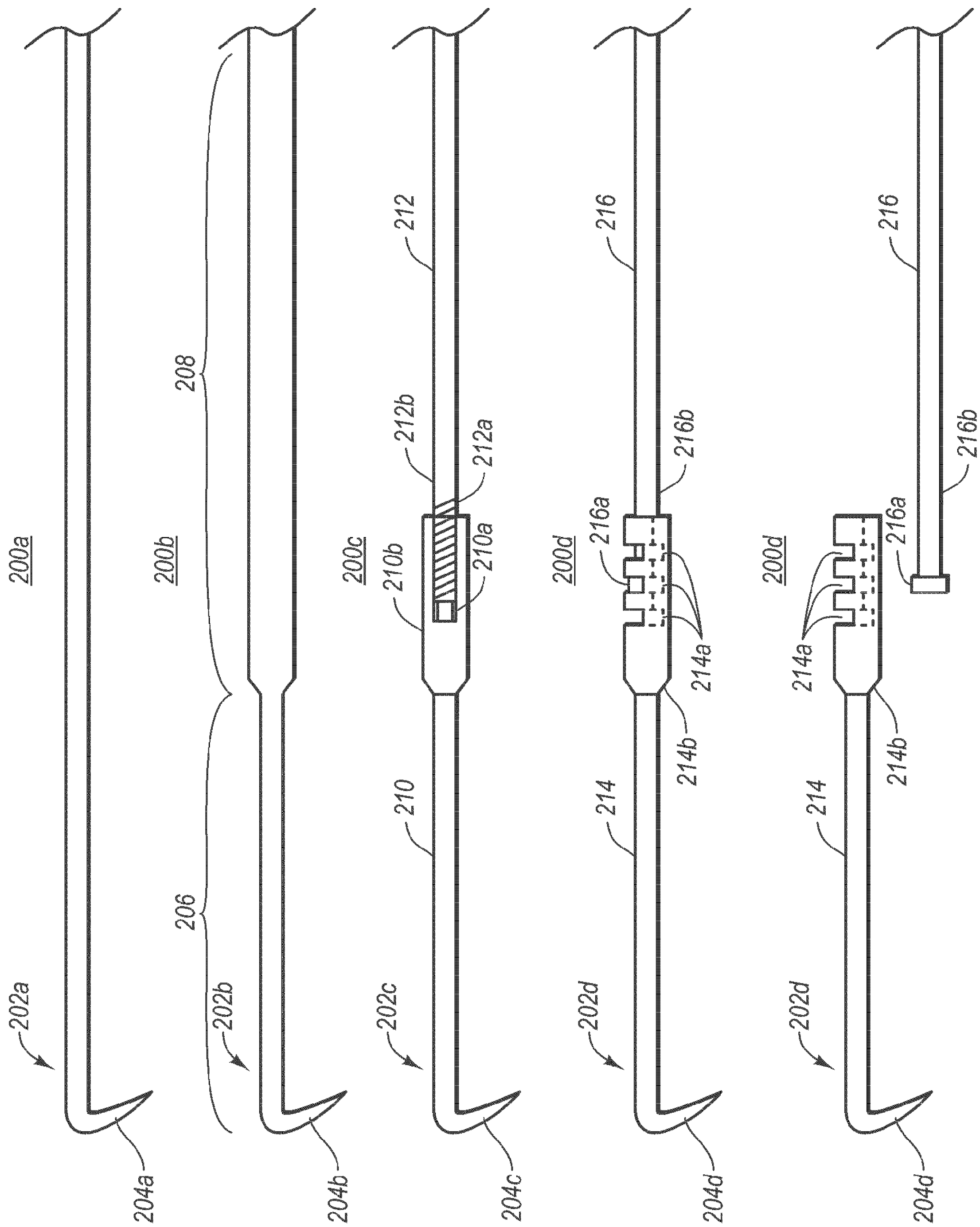


FIG. 1A

FIG. 1B

FIG. 1C

FIG. 2A FIG. 2B FIG. 2C FIG. 2D FIG. 2E



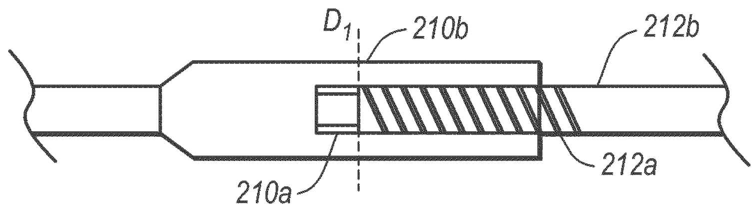


FIG. 2F

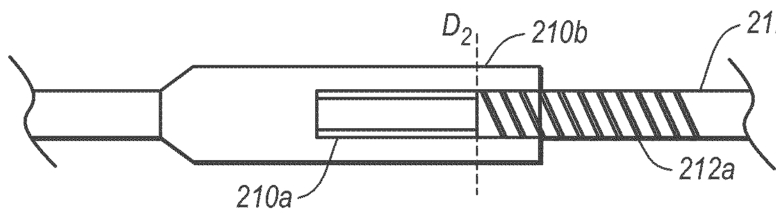


FIG. 2G

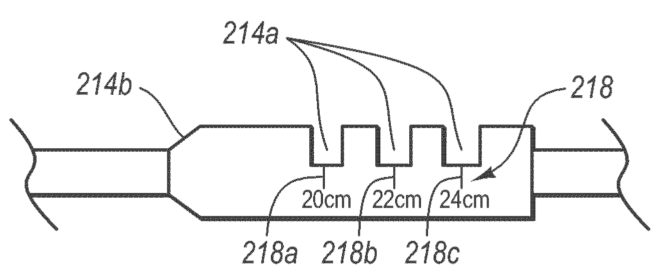


FIG. 2H

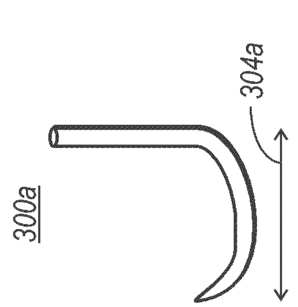


FIG. 3A

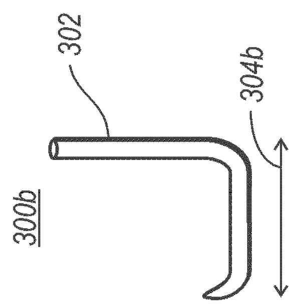


FIG. 3B

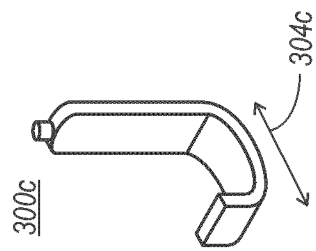


FIG. 3C

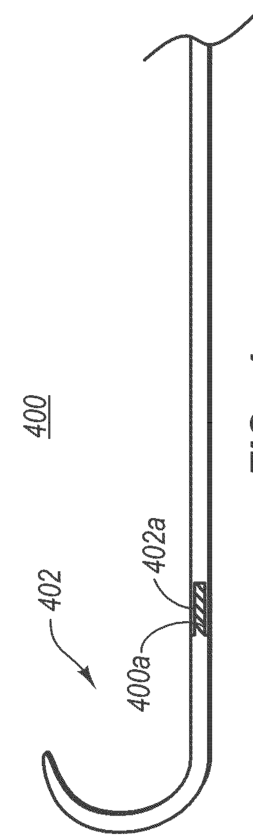


FIG. 4

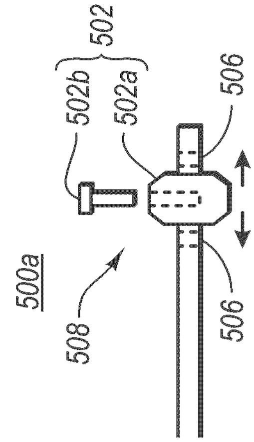


FIG. 5A

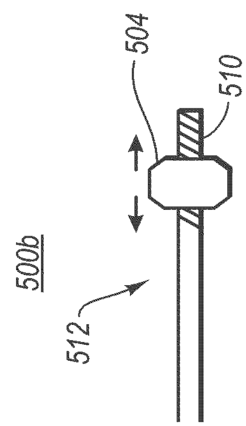


FIG. 5B

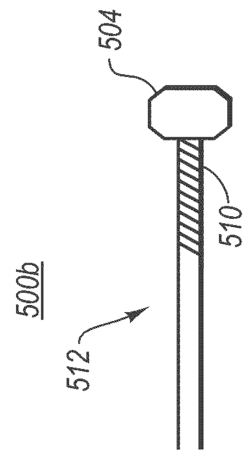


FIG. 5C

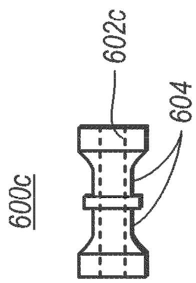


FIG. 6C

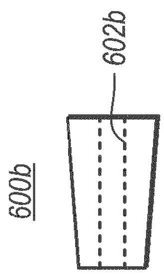


FIG. 6B

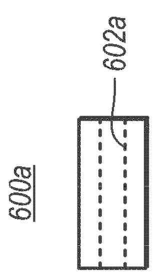


FIG. 6A

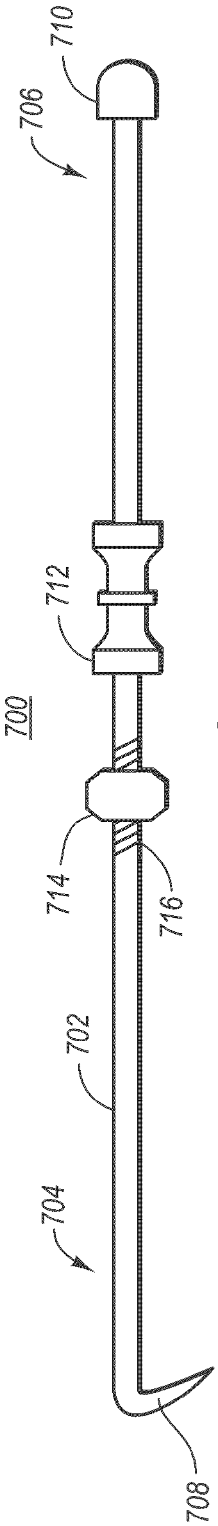


FIG. 7

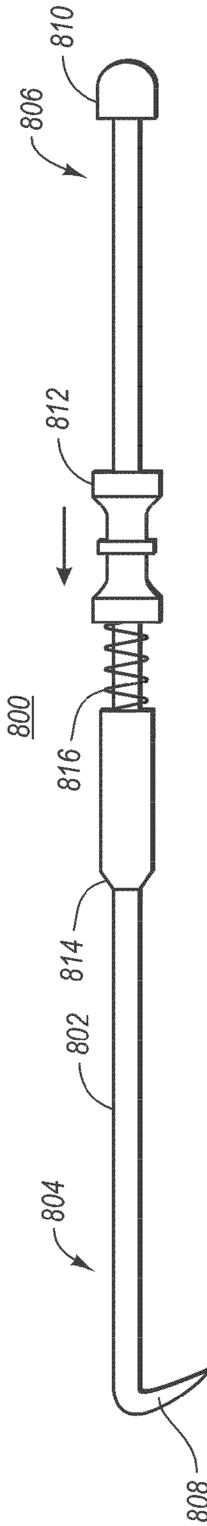


FIG. 8A

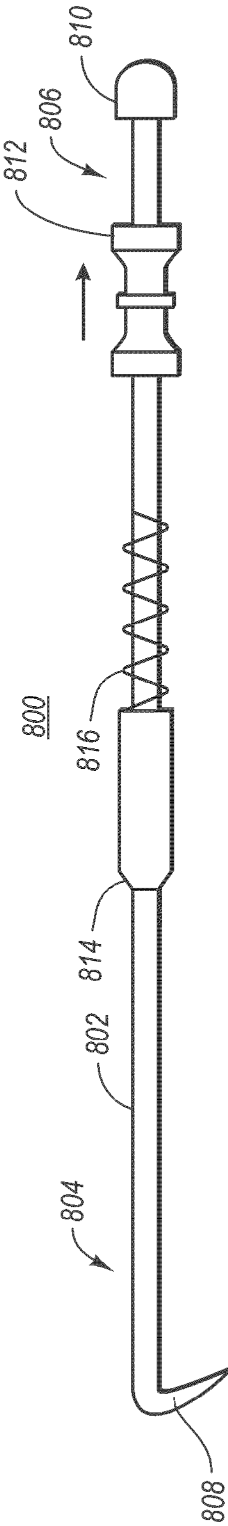


FIG. 8B

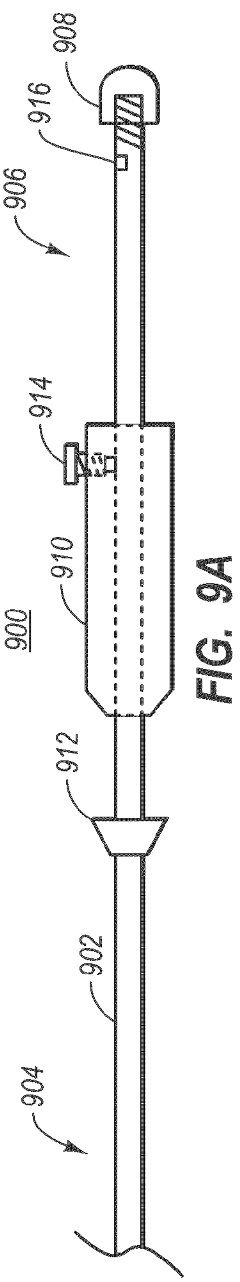


FIG. 9A

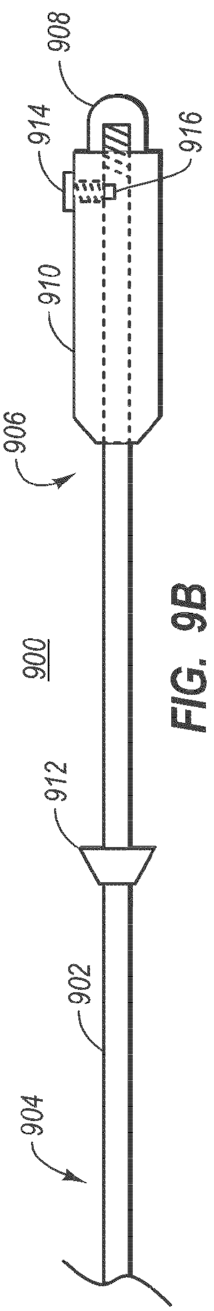


FIG. 9B

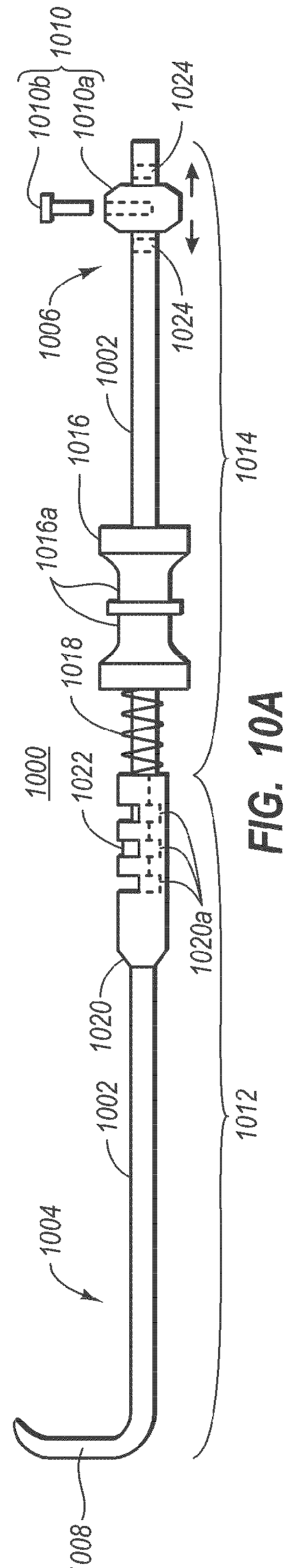


FIG. 10A

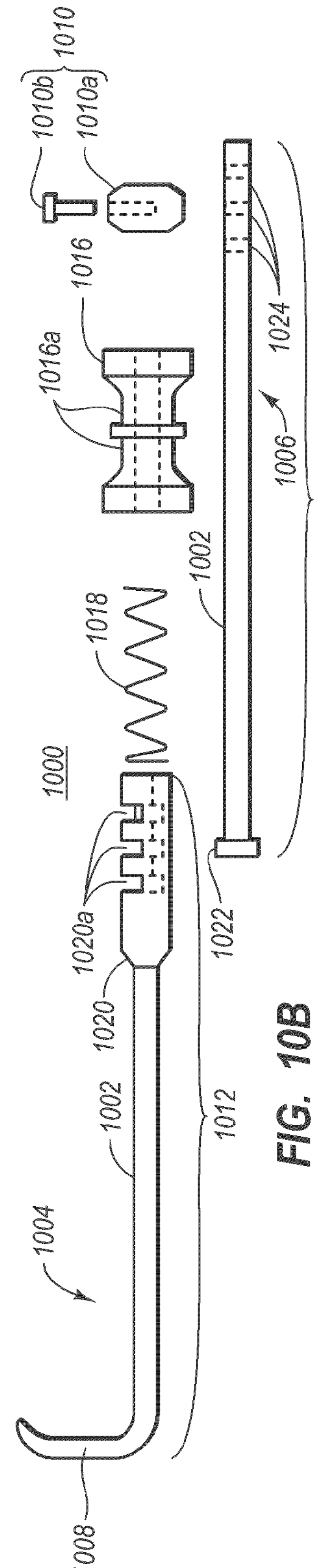


FIG. 10B

MEDICAL INSTRUMENTS FOR DIAPLASIS

TECHNICAL FIELD

The present disclosure relates to the field of medical devices.

BACKGROUND

Currently, in the diaplasis of fracture, e.g., zygomatic fracture, a single hook is generally used. However, it is sometimes difficult to obtain good diaplasis results just by depending on the single hook to retract the fractured bone segment, because human hands lack sufficient explosive force, or the force cannot be easily controlled once started. As a result, full traction reduction may not be achieved or the fractured ends may be over displaced under excessive force.

SUMMARY

In general, example embodiments relate to medical instruments. One example embodiment includes a medical instrument having a shaft and a movable element. The shaft has a first end and a second end. The first end includes an engaging member. The second end includes a stopping member. The movable element is configured to move along the shaft.

Another example embodiment includes a method of using a medical instrument. The method includes engaging a fractured bone segment with an engaging member included in a first end of a shaft of the medical instrument. The method also includes moving a movable element along the shaft towards a stopping member included in a second end of the shaft to create a force on the stopping member when the movable element comes in contact with the stopping member.

Yet another example embodiment includes a medical instrument having a shaft and a movable element. The shaft has a removably attachable first section and a removably attachable second section that are configured to be removably attached to each other. The removably attachable first section includes an engaging member. The removably attachable second section includes a first stopping member. The movable element has a through hole formed in it. The through hole has a shape that is complementary to a cross-sectional shape of at least a portion of the removably attachable second section. The movable element is configured to move along the at least a portion of the removably attachable second section.

The foregoing is a summary and thus contains, by necessity, simplifications, generalization, and omissions of detail; consequently, those skilled in the art will appreciate that the summary is illustrative only and is not intended to be in any way limiting. Other aspects, features, and advantages of the devices and/or processes and/or other subject matter described herein will become apparent in the teachings set forth herein. The summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE FIGURES

The foregoing and other features of the present disclosure will become more fully apparent from the following description and appended claims, taken in conjunction with the accompanying drawings. Understanding that these drawings depict only several embodiments in accordance with the disclosure and are, therefore, not to be considered limiting of its scope, the disclosure will be described with additional specificity and detail through use of the accompanying drawings.

FIG. **1**A is an illustrative embodiment of a medical instrument.

FIG. **1**B is a cross-sectional view of a portion of the medical instrument of FIG. **1**A.

FIG. **1**C is another embodiment of the cross-sectional view of FIG. **1**B.

FIGS. **2**A to **2**H show illustrative embodiments of shafts that can be implemented in the medical instrument of FIG. **1**A.

FIGS. **3**A to **3**C show illustrative embodiments of some engaging members that can be implemented in the medical instrument of FIG. **1**A.

FIG. **4** is an illustrative embodiment of a shaft having a removably attachable first end that can be employed in the medical instrument of FIG. **1**A.

FIGS. **5**A to **5**C show illustrative embodiments of shafts and removably attachable first stopping members that can be implemented in the medical instrument of FIG. **1**A.

FIGS. **6**A to **6**C show some example movable elements that can be employed in the medical instrument of FIG. **1**A.

FIG. **7** is a second illustrative embodiment of a medical instrument.

FIGS. **8**A and **8**B show a third illustrative embodiment of a medical instrument.

FIGS. **9**A and **9**B show a fourth illustrative embodiment of a medical instrument.

FIGS. **10**A and **10**B show a fifth illustrative embodiment of a medical instrument.

DETAILED DESCRIPTION

In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative embodiments described in the detailed description, drawings, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented herein. It will be readily understood that the aspects of the present disclosure, as generally described herein, and illustrated in the Figures, can be arranged, substituted, combined, separated, and designed in a wide variety of different configurations, all of which are explicitly contemplated herein.

Some embodiments include a medical instrument having a shaft and a movable element configured to move along the shaft. The shaft has a first end including an engaging member and a second end including a stopping member. As used herein, the term "engaging member" is to be construed broadly and may refer to a structure configured to provide contact with another structure, such as, but not limited to, a bone segment. Illustrative examples of such structures may include, but are not limited to, hooks, loops, picks, prongs, and shovel ends, among others.

In some embodiments, the engaging member is configured to engage a fractured bone segment of a subject. As used herein, the term "subject" should be broadly construed to include human subjects as well as animal subjects of all kinds such as, but not limited to, domesticated animals, zoo animals, farm animals, wild animals, endangered animals, race animals, working animals, pets, and aquatic animals. Illustrative examples of animals may include, but are not limited to, canines (e.g., dogs), felines (e.g., cats), equines (e.g., horses), birds, amphibians, reptiles, and other animal subjects. The movable element is moved along the shaft towards the stopping member. Upon coming in contact with the stopping member, the movable element applies a force to the stopping member, and hence to the engaging member via the shaft, for reduction of the fractured bone. Embodiments of the medical instrument can be applied to reduction of zygomatic fracture, e.g. zygomatic arch fracture, or other bone fractures.

I. First Example Medical Instrument

With reference first to FIG. **1**A, one example of a medical instrument **100** according to some embodiments is disclosed. As shown, the medical instrument **100** includes a shaft **102** having a first end **104** and a second end **106**. The first end **104** includes an engaging member **108**. The second end **106** includes a first stopping member **110**. The medical instrument additionally includes a movable element **112**. Briefly, the movable element **112** is configured to move along at least a portion of the shaft **102** so as to contact the first stopping member **110** and impart a force to the first stopping member **110**.

In some embodiments, the shaft **102** of the medical instrument **100** is a single piece lengthwise. For instance, the shaft **102** may be a single rod or pole made of steel, fiberglass, other suitable material(s), or any combination thereof. Alternatively, the shaft **102** may be made up of multiple strands or fibers that are arranged in parallel, braided, and/or twisted together.

In some embodiments, the shaft **102** has a substantially uniform diameter along its length. As such, the movable element **112** may be configured to move along substantially the entire length of the shaft **102** in some examples. In some other embodiments, the shaft **102** has a substantially uniform first diameter along a first section of the shaft **102** and a substantially uniform second diameter that is different than the first diameter along at least a second section of the shaft **102**. As such, the movable element **112** may be configured to move along one or the other of the first and second sections of the shaft **102**, but not along both of the first and second sections of the shaft **102**.

In these and other examples, the shaft **102** may be originally formed as a single piece, or it may be made into a single piece by irremovably joining different parts thereof into an integral piece.

Alternatively, the shaft **102** may be composed of more than one section, as explained further below with respect to, e.g., FIGS. **2**C-**2**E. For instance, in some embodiments, the shaft includes a first detachable section and a second detachable section that can be attached to each other. In some examples, the first and second detachable sections can be removably attached to each other, meaning the first and second detachable sections can be detached from each other and reattached to each other multiple times, if desired.

In this and other examples, the second detachable section may be screwed or clasped to the first detachable section. Alternatively or additionally, the second detachable section may be attached in other ways to the first detachable section using, for example, one or more pins, through holes, clips, nuts, bolts, adhesives, fasteners, or other mechanisms alone or in combination. In some embodiments, the medical instrument further comprises means for removably attaching the first detachable section and the second detachable section together.

In some embodiments, the attaching position of the second detachable section with respect to the first detachable section is adjustable in the length direction of the shaft **102**, as explained in greater detail below with respect to, e.g., FIGS. **2**C-**2**E. Briefly, for example, the second detachable section can be screwed onto the end of the first detachable section at any one of two or more positions determined at least by the pitch of the corresponding threads on the first and second detachable sections and the number of times the second detachable section is turned while being screwed onto the end of the first detachable section. As a result, some embodiments of the shaft are adjustable in length as described more fully below with respect to FIGS. **2**C-**2**E.

In some embodiments, the shaft **102** has a substantially circular cross-sectional shape and the movable element **112** includes a cavity **114** having a complementary cross-sectional shape, as illustrated in FIG. **1**B. FIG. **1**B depicts a cross-section of the shaft **102** and movable element **112** of FIG. **1**A along the cutting plane line **1**B of FIG. **1**A. As seen in FIG. **1**B, the cross-sectional shape of the shaft **102** is substantially circular and the cross-sectional shape of the cavity **114** of the movable element **112** is also substantially circular and complementary to the cross-sectional shape of the shaft **102**, allowing the movable element **112** to move lengthwise along at least a portion of the shaft **102**.

In other embodiments, the shaft **102** has a non-circular cross-sectional shape, and the movable element **112** includes a cavity having a complementary non-circular cross-sectional shape to allow the movable element **112** to move along at least a portion of the shaft **102**, while substantially preventing rotation of the movable element with respect to the shaft **102**. For instance, FIG. **1**C depicts a cross-section through an alternative shaft **102***a* and movable element **112***a*. As shown, the cross-sectional shape of the shaft **102***a* is substantially square and the cross-sectional shape of the cavity **114***a* of the movable element **112***a* is also substantially square and complementary to the cross-sectional shape of the shaft **102***a*, allowing the movable element **112***a* to move lengthwise along at least a portion of the shaft **102***a*.

Further, the non-circular shape of the cross-section of the shaft **102***a* substantially prevents the movable element **112***a* from rotating with respect to the shaft **102***a*. More particularly, the non-circular cross-sectional shape of the shaft **102** substantially prevents the movable element **112***a* from rotating about a center axis **116** of the shaft **102***a* independent of the shaft **102***a*.

It is understood that the substantially square cross-sectional shapes of the shaft **102***a* and the cavity **114***a* are only one example of non-circular cross-sectional shapes that can be employed to substantially prevent a movable element from rotating with respect to a shaft. Other examples of non-circular cross-sectional shapes include polygonal cross-sectional shapes such as rectangles, hexagons, or trapezoids, to name a few, and cross-sectional shapes that include combinations of curved and straight lines.

In the description that follows, each of the components of the medical instrument **100** and/or of additional components that can be implemented in some embodiments of a medical instrument will be described in greater detail below. For instance, various example ranges will be provided for one or more parameters of the components of the medical instrument **100**, the parameters including one or more of length, width, diameter, mass, or the like. In some embodiments, the various components of the medical instrument **100** may be proportionately sized for the location, the bone, and/or the subject. It will be appreciated that the specific ranges discussed below are given by way of example only. Further, the values of the parameters may be varied to suit a particular application depending on, for example, the size of the subject and/or the bone to be fixed on the subject.

By way of example, a medical instrument **100** configured to reduce a fracture of a relatively large bone fragment and/or of a relatively large subject could have a shaft **102** having a length of about 40 centimeters (cm) and a diameter of about 1 cm, an engaging member **108** having a width of about 5 cm, and a movable element **112** having a mass of about 1000 grams (g). Alternatively, a medical instrument **100** configured to reduce a fracture of a relatively small bone fragment and/or of a relatively small subject could have a shaft **102** having a length of about 20 cm and a diameter of about 0.5 cm, an engaging member **108** having a width of about 3 cm, and a movable element **112** having a mass of about 20 grams (g). These are only two of numerous possible combinations.

A. Shafts

Turning next to FIGS. **2**A-**2**E, some example shafts **200***a*, **200***b*, **200***c*, and **200***d* are illustrated that may correspond to the shaft **102** of FIG. **1**A and that can be employed in a medical instrument, such as the medical instrument **100** of FIG. **1**A. A length of the shafts **200***a*-**200***d* may be in the range of about 20 centimeters (cm) to about 40 cm. In some examples, the length of the shafts **200***a*-**200***d* is substantially equal to about 30 cm. In other examples the length of the shafts **200***a*-**200***d* may be less than 20 cm or greater than 40 cm. A diameter of the shafts **200***a*-**200***d* may be in the range of about 0.5 cm to about 1 cm. In other examples, the diameter of the shafts **200***a*-**200***d* may be less than 0.5 cm or greater than 1 cm.

Although not required, the shafts **200***a*-**200***d* may be formed from stainless steel, titanium alloy, fiberglass, wood, plastic, other suitable material(s), or any combination thereof. Further, the shafts **200***a*-**200***d* may be disposable or reusable. Alternatively or additionally, the shafts **200***a*-**200***d* may be sterilizable.

As shown in FIGS. **2**A-**2**E, each of the shafts **200***a*, **200***b*, **200***c*, **200***d*, has, respectively, a first end **202***a*, **202***b*, **202***c*, **202***d* including an engaging member **204***a*, **204***b*, **204***c*, **204***d*.

In the examples illustrated in FIGS. **2**A and **2**B, the shafts **200***a* and **200***b* are each formed of a single section. The shaft **200***a* shown in FIG. **2**A has a substantially uniform diameter over the length of the shaft **200***a*. As used herein, a shaft **200***a* is substantially uniform in diameter if the diameter of the shaft **200***a* remains constant along the length of the shaft **200***a*.

In comparison, the shaft **200***b* of FIG. **2**B includes multiple portions with different diameters. In particular, the shaft **200***b* of FIG. **2**B includes a first portion **206** with a first diameter and a second portion **208** with a second diameter different than the first diameter. For instance, the first portion **206** may have a diameter substantially equal to about 0.5 cm, while the second portion **208** may have a diameter substantially equal to about 1 cm.

FIG. **2**C illustrates a shaft **200***c* comprising a first detachable section **210** and a second detachable section **212** that are configured to be removably attached to each other. As illustrated, the first detachable section **210** includes the first end **202***c* and engaging member **204***c*. Although not shown, the second detachable section **212** includes a corresponding second end and first stopping member.

As shown in FIG. **2**C, the first detachable section **210** includes internal thread **210***a* at an end **210***b* opposite to the first end **202***c* of the shaft **200***c*, and the second detachable section **212** includes external thread **212***a* at a corresponding end **212***b* of the second detachable section **212** that can be removably engaged with the internal thread **210***a* of the first detachable section **210**. Alternatively, the internal thread **210***a* may be formed in the end **212***b* of the second detachable section **212**, and the external thread **212***a* may be formed on the end **210***b* of the first detachable section **131**. In either configuration, the threaded end **210***b* of the first detachable section **210** and the threaded end **212***b* of the second detachable section **212** represent one example of a structural implementation of a means for removably attaching the first detachable section **210** and the second detachable section **212** together.

In some embodiments, the length of the shaft **200***c* can be adjusted by varying the depth by which the external thread **212***a* is engaged with the internal thread **210***a*. For instance, FIG. **2**F illustrates an example where the external thread **212***a* is engaged with the internal thread **210***a* to a depth D_1, while FIG. **2**G illustrates an example where the external thread **212***a* is engaged with the internal thread **210***a* to a depth D_2. Depending on whether the external thread **212***a* is engaged with the internal thread **210***a* to the depth D_1 or D_2, or any other depth, the length of the shaft **200***c* will be adjusted accordingly.

Although not required in all embodiments, as shown in FIG. **2**C, the end **210***b* of the first detachable section **210** has a larger diameter than the other portion of shaft **200***c*. Alternatively or additionally, the end **212***b* of the second detachable section **212** can have a larger diameter than the other portion of the shaft **200***c*. In either configuration, the portion having the larger diameter may serve as a handle portion which facilitates grasping of the shaft **200***c*. Alternatively or additionally, the portion having the larger diameter may serve as a second stopping member to confine a corresponding movable element to motion along the second detachable section **212**. Second stopping members are described in greater detail below with respect to FIGS. **7**-**10**B.

In some embodiments, the portion having the larger diameter can include a pattern or coating on its surface to prevent slippage during grasping of the shaft **200***c*. For instance, a plurality of depressions, e.g., dimples, can be formed in a pattern on the surface of the portion having the larger diameter. Alternatively or additionally, a plurality of protrusions can be formed in a pattern on the surface of the portion having the larger diameter. Alternatively or additionally, a rubber or latex coating can be applied to the surface of the portion having the larger diameter.

Similar to FIG. **2**C, FIGS. **2**D and **2**E illustrate a shaft **200***d* that includes two detachable sections **214**, **216**. In particular, FIG. **2**D illustrates the shaft **200***d* in an assembled configuration, while FIG. **2**E illustrates the shaft **200***d* in a disassembled configuration. As illustrated, the first detachable section **214** includes the first end **202***d* and engaging member **204***d*. Although not shown, the second detachable section **216** includes a corresponding second end and first stopping member.

In the example of FIGS. **2**D and **2**E, a plurality of retaining slots **214***a* are provided at an end **214***b* of the first detachable section **214** opposite to the first end **202***d* of the shaft **200***d*. In some embodiments, each retaining slot **214***a* is a recessed cavity. Alternatively, each of the retaining slots **214***a* may comprise a through hole formed in the end **214***b* of the first detachable section **214**, or a tapped hole formed in the end **214***b* of the first detachable section **214**.

Each retaining slot **214***a* is configured to receive a flange, pin, or fastener **216***a* provided at an end **216***b* of the second detachable section **216** and to retain the flange **216***a* so as to clasp the second detachable section **216** to the first detachable section **214**. Alternatively, the retaining slots **214***a* may be formed in the end **216***b* of the second detachable section **216** and the flange **216***a* may be provided at the end **214***b* of the first detachable section **214**. In either configuration, the retaining slot(s) **214***a* and the flange **216***a* represent an example of a structural implementation of a means for removably attaching the first detachable section **214** and the second detachable section **216** together.

In some embodiments, the length of the shaft **200***d* can be adjusted by inserting the flange **216***a* into a different one of the retaining slots **214***a*. Alternatively, the first detachable section **214** can include a single retaining slot **214***a* such that the length of the shaft **200***d* is not adjustable while still permitting the first and second detachable sections **214**, **216** to be removably attached to each other.

Although not required in all embodiments, in some embodiments the shafts **200***c* and **200***d* can include scale marks on at least part of the shaft **200***c*, **200***d* to provide a reference for adjusting the length of the shaft **200***c*, **200***d*. For example, FIG. **2**H illustrates an example of the end **214***b* of the first detachable section **214** of the shaft **200***d* of FIGS. **2**D-**2**E. As shown in FIG. **2**H, a scale **218** is provided on the end **214***b* indicating a length of the shaft **200***d* when the flange **216***a* is received by a corresponding retaining slot **214***a*. In the illustrated embodiment of FIG. **2**H, the length of the shaft **200***d* is about 20 cm when the flange **216***a* is received in the left-most slot **214***a*, as indicated by scale mark **218***a*, the length of the shaft **200***d* is about 22 cm when the flange **216***a* is received in the middle slot **214***a*, as indicated by scale mark **218***b*, and the length of the shaft **200***d* is about 24 cm when the flange **216***a* is received in the right-most slot **214***a*, as indicated by scale mark **218***c*. In other embodiments, the scale **218** may be provided in other forms and/or with different incrementation and labeling.

Adjustable shaft **200***c*, **200***d* lengths can provide a corresponding movable element, such as the movable element **112** of FIG. **1**A, with different moving lengths along the shaft **200***c*, **200***d*.

B. Engaging Members and First Ends

With additional reference to FIGS. **3**A, **3**B and **3**C, some example engaging members **300***a*, **300***b*, **300***c* are illustrated that may correspond to the engaging member **108** of FIG. **1**A and that can be implemented in the first end of a medical instrument, such as in the first end **104** of the medical instrument **100** of FIG. **1**A. The engaging members **300***a*, **300***b*, **300***c* have a variety of configurations. For instance, as shown in FIG. **3**A, the engaging member **300***a* is curved, whereas the engaging member **300***b* of FIG. **3**B substantially forms an angle of about 90° with respect to a corresponding shaft **302**, and the engaging member **300***c* of FIG. **3**C takes a form of a flat hook which has a thin elongated cross-section. The configurations of FIGS. **3**A-**3**C can be combined and/or rearranged.

Alternatively, an engaging member may include a stick-like structure that has been screwed, pinned, welded, or otherwise attached to or formed on a first end of a shaft in a tau or "T" shaped configuration.

In some embodiments, a width **304***a*, **304***b*, **304***c* of the engaging members **300***a*, **300***b*, **300***c* is in the range of about 3 cm to about 5 cm. In some other embodiments, the widths **304***a*, **304***b*, **304***c* of engaging members **300***a*, **300***b*, **300***c* is less than 3 cm or more than 5 cm.

Returning to FIG. **1**A, and as mentioned above, the first end **104** of the shaft **102** may be formed integrally with or irremovably fixed to the shaft **102**. Alternatively, the first end **104** of the shaft **102** may be removably attached to the shaft **102**, and thus can be removed for, e.g., sterilization, and/or replaced as needed.

For instance, FIG. **4** illustrates an embodiment of a shaft **400** including a removable first end **402**. As shown in FIG. **4**, the first end **402** is formed with external thread **402***a* which may be engaged with corresponding internal thread **400***a* formed in the shaft **400**. In some other embodiments, both of the first end **402** and the shaft **400** may be provided with external thread so that they can be removably attached together by using a screw nut configured to engage both of them. In this and other embodiments, the ability to removably attach the first end **402** to the shaft **400** allows the shaft **400** to be used with any one of multiple first ends **402** of different forms, sizes and/or materials to offer a user the opportunity of replacing the first end to suit different applications and/or as otherwise desired. For instance, one first end **402** may include a curved engaging member such as depicted in FIG. **3**A, another first end **402** may include a 90° angle engaging member such as illustrated in FIG. **3**B, and yet another first end **402** may include a flat hook engaging member such as shown in FIG. **3**C. Each of the different first ends **402** may be suited for one or more different uses. A collection of multiple and/or varying first ends **402** together with other parts of a corresponding medical instrument may form a kit.

It will be appreciated, with the benefit of the present disclosure, that the different embodiments disclosed herein can be combined together and/or implemented separately. For instance, removable first ends **402** can be implemented in conjunction with one piece shafts, such as the shafts **200***a*, **200***b* of FIGS. **2**A and **2**B, or in conjunction with shafts having multiple detachable sections, such as the shafts **200***c* and **200***d* of FIGS. **2**C-**2**E.

C. First Stopping Members

Returning to FIG. **1**A, the first stopping member **110** may be formed integrally with the shaft **102**, the first stopping member **110** may be fixedly secured to the shaft **102**, or the first stopping member **110** may be removably attached to the shaft **102**. In some embodiments, the first stopping member **110** is glued, welded, screwed or pinned to the shaft **102**. In some embodiments, the medical instrument **100** further comprises means for removably attaching the first stopping member **110** to the shaft **102**. Alternatively or additionally, the attaching position of the first stopping member **110** with respect to the shaft **102** may be adjustable along the length of the shaft **102**.

For example, FIGS. **5**A and **5**B illustrate example shafts **500***a*, **500***b* and first stopping members **502**, **504** that may respectively correspond to the shaft **102** and first stopping member **110** of FIG. **1**A. For the sake of clarity, only part of the shaft **500***a*, **500***b* and the first stopping member **502**, **504** are shown in FIGS. **5**A and **5**B. In the examples of FIGS. **5**A and **5**B, each first stopping member **502**, **504** is removably attachable to shaft **500***a*, **500***b*, respectively.

In the example of FIG. **5**A, the first stopping member **502** includes a main body **502***a* and a pin **502***b* configured to be inserted through a hole in the main body **502***a*. The main body **502***a* may have a variety of shapes, including a circular cylinder shape, a hexagonal shape, a cube or other rectangular box shape, or the like or any combination thereof.

At least one pin hole **506** is formed in a second end **508** of the shaft **500***a*, to which the first stopping member **502** is attached. The at least one pin hole **506** is arranged along the length direction of the shaft **500***a*. In some embodiments in which a plurality of pin holes **506** are formed in the second end **508**, the attaching position of the first stopping member **502** with respect to the shaft **500***a* can be adjusted by inserting the pin **502***b* into a different one of the pin holes **506** along the length of the shaft **410**. The pin **502***b*, the hole in the main body **502***a*, and the pin hole **506** represent one example of a structural implementation of a means for removably attaching the first stopping member **502** to the shaft **500***a*.

In some embodiments, internal threads are provided within the pin hole **506**. As such, a threaded bolt or screw, rather than the pin **502***b*, can be provided for removably attaching the main body **502***a* to the shaft **500***a*.

In the example of FIG. **5**B, the first stopping member **504** is in a form of a nut having internal thread, which can be engaged with external thread **510** formed on a second end **512** of the shaft **500***b*. As such, the first stopping member **504** may have a hexagonal shape, or other shapes such as a circular cylinder, cube, or rectangular box shape. Alternatively or additionally, the first stopping member **504** can be in a form of a cap nut.

In some embodiments, the attaching position of the first stopping member **504** with respect to the shaft **500***b* can be adjusted by screwing the first stopping member **504** in or out with respect to the shaft **500***b*. More particularly, and analogous to the explanation give above with respect to FIGS. **2**F and **2**G, the position of the first stopping member **504** can be adjusted by the internal thread of the first stopping member **504** engaging the external thread **510** to different depths. The internal thread of the first stopping member **504** and the external thread of the shaft **500***b* represent one example of a structural implementation of a means for removably attaching the first stopping member **504** to the shaft **500***b*.

FIGS. **5**A and **5**B illustrate examples of first stopping members **502**, **504** that can be removably attached to shafts **500***a*, **500***b* using a pin **502***b* and pin hole **506** in the example of FIG. **5**A, and using internal and external threads in the example of FIG. **5**B. Alternatively or additionally, first stopping members are removably attached to shafts using one or more pins, pin holes, internal thread, external thread, screws, bolts, nuts, retaining clips, or other mechanisms implemented individually or in any combination.

As illustrated in FIGS. **5**A and **5**B, some embodiments allow the position of first stopping members **502**, **504** to be adjusted with respect to shafts **500***a*, **500***b*. Adjustable first stopping members **502**, **504** can provide a corresponding movable element, such as the movable element **112** of FIG. **1**A, with different moving lengths along the shaft **500***a*, **500***b*.

For example, FIG. **5**C illustrates the shaft **500***b* with the first stopping member **504** positioned substantially at the end of second end **512**. In comparison with the configuration of FIG. **5**B, the configuration of FIG. **5**C increases the length along the shaft **500***b* over which a corresponding movable element can travel.

The force generated by a corresponding movable element on the first stopping members **502**, **504** may at least partially depend on the length of the shaft **500***a*, **500***b* over which the corresponding movable element is allowed to move. As such, the use of adjustable first stopping members **502**, **504** may permit adjustment of the force generated by the corresponding movable element on the first stopping member **502**, **504** during operation.

The first stopping member **502**, **504** may be of any shape and size configured to stop the movement of the corresponding movable element stably to generate a force. In some embodiments, the first stopping member **502**, **504** has a flat surface facing a corresponding first end of the shaft **500***a*, **500***b* with at least one dimension along the flat surface that is greater than that of the movable element so as to substantially stop forward movement of the movable element when it contacts the first stopping member **502**, **504**. The first stopping member may be made of metal, plastic, and/or other suitable material(s).

D. Movable Elements

Turning next to FIGS. **6**A, **6**B, and **6**C, some example movable elements **600***a*, **600***b*, **600***c* are illustrated that may correspond to the movable element **112** of FIG. **1**A and that can be implemented in a corresponding medical instrument, such as the medical instrument **100** of FIG. **1**A.

The movable element **600***a* shown in FIG. **6**A generally has a cylindrical shape with a through-hole **602***a* formed in the axial direction of the movable element **600***a*. As such, the movable element **600***a* may have a cross-sectional outer perimeter that is substantially circular in shape, such as shown in FIGS. **1**A and **1**B with respect to movable elements **112**, **112***a*.

The movable element **600***b* shown in FIG. **6**B generally has a frustoconical shape (e.g., a truncated cone) with a through-hole **602***b* formed in the axial direction of the movable element **600***b*. As such, the movable element **600***b* may also have a cross-sectional outer perimeter that is also substantially circular in shape, although the diameter of the movable element **600***b* may vary linearly along the length of the movable element **600***b*.

The movable element **600***c* shown in FIG. **6**C has a through-hole **602***c* formed in the axial direction of the movable element **600***c* and further includes contours **604** formed on its outer surface.

FIGS. **6**A, **6**B and **6**C illustrate movable elements **600***a*, **600***b*, **600***c* having particular shapes, including cylindrical, frustoconical, and contoured. In each of these examples, the movable elements **600***a*-**600***c* may have cross-sectional outer perimeters that are substantially circular in shape, such as illustrated in FIGS. **1**A and **1**B. However, the shapes of the cross-sectional outer perimeters of movable elements **600***a*, **600***b*, **600***c* illustrated in FIGS. **6**A, **6**B and **6**C should not be construed to be limiting. For example, movable elements according to some embodiments can have cross-sectional outer perimeters of other shapes such as polygonal, including rectangular, triangular, hexagonal, trapezoidal, etc., or a combination of curved and straight lines. Further, the movable elements **600***a*, **600***b*, **600***c* may have different sizes according to a particular usage.

More generally, the movable element **600***a*, **600***b*, **600***c* may be a mass of any shape having a through hole formed therein, where the through hole has a cross-sectional shape that is complementary to the cross-sectional shape of the corresponding shaft along which the movable element **600***a*, **600***b*, **600***c* moves, as illustrated and described above with respect to FIGS. **1**A and **1**B. Alternatively or additionally, surface textures, contours, dents or coatings may be provided on the outer surface of the movable element **600***a*, **600***b*, **600***c* to facilitate the manipulation of the movable element **600***a*, **600***b*, **600***c*. For instance, the outer surface of the movable element **600***a*, **600***b*, **600***c* can include a plurality of depressions or a plurality of protrusions formed thereon, a rubber or latex coating applied thereon, or the like or any combination thereof.

Further, the mass of the movable element **600***a*, **600***b*, **600***c* may be configured to suit a particular application. In some embodiments, the mass of the movable element **600***a*, **600***b*, **600***c* is in the range of about 20 g to about 1000 g. Specifically, the mass of the movable element **600***a*, **600***b*, **600***c* may be in the range of about 100 g to about 500 g. In some embodiments, the mass of the movable element **600***a*, **600***b*, **600***c* is about 200 g. In other embodiments, the mass of the movable element **600***a*, **600***b*, **600***c* is less than 20 g or more than 1000 g. In embodiments that include shafts with removable first stopping members, such as the shafts **500***a*, **500***b* of FIGS. **5**A and **5**B, the movable element **600***a*, **600***b*, **600***c* can be assembled with and dissembled from the corresponding shaft **500***a*, **500***b* at the second end **508**, **512** of the shaft **500***a*, **500***b*. For instance, with the first stopping member **502**, **504** removed from shafts **500***a*, **500***b*, movable element **600***a*,

600*b*, or **600***c* could be assembled onto shaft **500***a*, **500***b* and then the movable element **600***a*, **600***b*, or **600***c* could be attached to the shaft **500***a*, **500***b* to prevent the movable element **600***a*, **600***b*, or **600***c* from being removed. To remove the movable element **600***a*, **600***b*, or **600***c* from shaft **500***a*, **500***b*, the first stopping member **502**, **504** could then be removed from the shaft **500***a*, **500***b*.

Alternatively or additionally, in embodiments that include shafts with first and second detachable sections, such as shafts **200***c*, **200***d* of FIGS. 2C-2E, the movable element **600***a*, **600***b*, **600***c* can be assembled with and dissembled from the corresponding shaft **200***c*, **200***d* by first disengaging the first detachable section **210**, **214** from the second detachable section **212**, **216** of the shaft **200***c*, **200***d*. For example, with the first detachable section **210**, **214** disengaged from the second detachable section **212**, **216**, the movable element **600***a*, **600***b*, **600***c* could be assembled onto the second detachable section **212**, **216**, and then the first detachable section **210**, **214** and second detachable section **212**, **216** could be attached together to prevent the movable element **600***a*, **600***b*, or **600***c* from being removed. To remove the movable element **600***a*, **600***b*, **600***c*, the first detachable section **210**, **214** and second detachable section **212**, **216** would be detached from each other.

Accordingly, a collection of movable elements **600***a*, **600***b*, **600***c* of different shapes, surface features and/or masses together with other parts of a corresponding medical instrument may form a kit.

Further, each of the different components of the medical instrument described herein may be formed from one or more of stainless steel, titanium alloy, plastic, medical ceramic, or other suitable material(s).

II. Example Method of Medical Instrument Use

Medical instruments according to some embodiments can be used in a variety of ways. In one example method, and with reference to FIG. **1**A, a fractured bone segment (not shown) is engaged by the engaging member **108**. Engaging the fractured bone segment with the engaging member **108** may include making the engaging member **108** hook on the fractured bone segment. The movable element **112** is moved along the shaft **102** towards the first stopping member **110** to create a force on the first stopping member **110** when the movable element **112** contacts the first stopping member **110**. Upon coming in contact with the stopping member, the movable element applies a force to the stopping member, and hence to the engaging member via the shaft, for reduction of the fractured bone. In some embodiments, the force may be at least partially controlled by one or more of the following factors: the mass of the movable element **112**, the moving length of the movable element **112** along the shaft **102**, the moving speed of the movable element **112** towards the first stopping member **110**, the force to move the movable element **112** towards the first stopping member **110** exerted by a user of the medical instrument **100** or generated by a spring provided on the shaft as will be explained below with reference to FIGS. **8**A-**8**B and **10**A-**10**B. Those skilled in the art will understand, however, that manual manipulation of the movable element and spring-based operation are only illustrative examples of implementation of moving the movable element. Alternatively or additionally, automatic control means, such as, but not limited to, digital setting, pre-programmed protocol, real-time control and intelligent adjustment may be involved to different extents. Other embodiments will be apparent to those skilled in the art.

Alternatively or additionally, and with additional reference to FIG. **4**, the method may include attaching the first end **402** to the shaft **400**. In some embodiments, attaching the first end **402** to the shaft **400** may include screwing an external thread **402***a* formed in one of the first end **402** and the shaft **400** into an internal thread **400***a* formed on the other one of the shaft **400** or first end **402**, or it may include engaging a nut with external threads formed on both of the first end **402** and the shaft **400** to attach them to each other.

Alternatively or additionally, and with additional reference to FIGS. **2**C-**2**E, the method may include attaching the second detachable section **212**, **216** and the first detachable section **210**, **214** together. The method may include adjusting the attaching position of the second detachable section **212**, **216** with respect to the first detachable section **210**, **214**. In some embodiments, attaching the second detachable section **212** and the first detachable section **210** together may include attaching them by thread engagement, and the attaching position is adjustable by changing the depth by which the thread engagement advances. In other embodiments, the attaching of the second detachable section **216** and the first detachable section **214** together may include inserting a flange **216***a* formed on an end of one the two sections **216**, **214** into a retaining slot **214***a* formed in an end of the other one of the two sections **214**, **216**. In this case, the attaching position may be adjusted by relocating the flange **216***a* to another retaining slot **214***a*.

Alternatively or additionally, and with additional reference to FIGS. **5**A and **5**B, the method may include attaching the first stopping member **502**, **504** to the shaft **500***a*, **500***b*. The method may include adjusting the attaching position of the first stopping member **502**, **504** with respect to the shaft **500***a*, **500***b*. In some embodiments, attaching the first stopping member **502** to the shaft **500***a* may include inserting a pin **502***b* through the first stopping member **502** into a corresponding hole **506** formed in the shaft **500***a*, and adjusting the attaching position may include relocating the pin **502***b* through the first stopping member **502** into a different hole **506**. In other embodiments, attaching the first stopping member **504** to the shaft **500***b* may include screwing the first stopping member **504** onto the shaft **500***b*, and adjusting the attaching position may include screwing the first stopping member **504** further in or out.

Alternatively or additionally, as will be explained below with reference to FIGS. **9**A and **9**B, the method may include locking a movable element with respect to a corresponding shaft. The locking may include engaging a locking bolt which goes through the movable element into a locking hole in the shaft.

Alternatively or additionally, as will be explained below with reference to FIGS. **8**A-**8**B and **10**A-**10**B, moving a movable element along a corresponding shaft may include biasing or compressing a spring by pushing the movable element against the spring and then releasing the movable element.

Alternatively or additionally, the method may include selecting a movable element from among a set of movable elements.

III. Second Example Medical Instrument

FIG. **7** shows a second example embodiment of a medical instrument **700** having a shaft **702** with a first end **704** and a second end **706**. The first end **704** includes an engaging member **708** and the second end **706** includes a first stopping member **710**. The medical instrument **700** also includes a movable element **712** and a second stopping member **714**. As shown in FIG. **7**, the second stopping member **714** is positioned on the shaft **702**. The second stopping member **714** is configured to cooperate with the first stopping member **710** to confine the movable element **712** between the first stopping member **710** and the second stopping member **714** along the shaft **702**. In some embodiments, the second stopping member **714** is configured to be removably attached to the shaft **702** at any one of a plurality of positions. In the illustrated embodiment, the second stopping member **714** is screwed onto external thread **716** provided on the shaft **702**. The attaching position of the second stopping member **714** with respect to the shaft **702** is adjustable in the length direction of the shaft **702** in this example by screwing the second stopping member **714** in or out. As a result, the range over which the movable element **712** is allowed to move along the shaft **702** can be adjusted. Alternatively, the second stopping member **714** can be formed as an integral part of the shaft **702** having a diameter that is larger than a diameter of the portion of the shaft **702** over which the movable element **712** is configured to move. Alternatively or additionally, the second stopping member **714** can be attached to the shaft **702** in a manner that does not permit adjustment of the attaching position of the second stopping member **714** with respect to the shaft **702**. In some embodiments, the medical instrument **700** further comprises means for removably attaching the second stopping member **714** to the shaft **702**.

In FIG. **7**, the second stopping member **714** is shown as a separately provided element. In other embodiments, the second stopping member **714** is integral with one or more other components of the medical instrument **700**. For example, in FIG. **2**C, the end **210***b* of the first detachable section **210** of shaft **200***c* can function as a second stopping member. Alternatively, in FIGS. **2**D and **2**E, the end **214***b* of first detachable section **214** of shaft **200***d* can function as a second stopping member. Other configurations are also contemplated. As such, in the embodiment of FIG. **7**, the forms of the shaft **702**, the first end **704**, the movable element **712**, the first stopping member **710**, and the second stopping member **714** are given by way of example, and not by way of limitation.

One or more of the embodiments described above with respect to FIGS. **2**A-**6**C can be combined with the embodiment of FIG. **7**.

IV. Third Example Medical Instrument

FIGS. **8**A and **8**B show a third example embodiment of a medical instrument **800** having a shaft **802** with a first end **804** and a second end **806**. The first end **804** includes an engaging member **808** and the second end **806** includes a first stopping member **810**. The medical instrument **800** also includes a movable element **812**, a second stopping member **814**, and a spring **816** provided between the second stopping member **814** and the movable element **812**. In this and other examples, the spring **816** is provided to energize the movement of the movable element **812** along the shaft **802**. FIG. **8**A shows a state in which the movable element **812** is pushed against the spring **816** to bias the spring **816**, and FIG. **8**B shows a state in which the movable element **812** is energized by the spring **816** to move toward the first stopping member **810** after the movable element **812** is released.

One or more of the embodiments described above with respect to FIGS. **2**A-**7** can be combined with the embodiment of FIGS. **8**A and **8**B. In some embodiments, the spring **816** is a helical spring which is guided by the shaft **802** to contract and expand.

During reduction of fracture, such as reduction of zygomatic fracture, after engaging the bone fracture segment with the engaging member **808**, the movable element **812** may be pushed against the spring **816** to bias the spring **816** against the second stopping member **814**, thereby compressing the spring **816**. Then, when the movable element **812** is released, the compressed spring **816** expands and energizes the movable element **812** to move toward the first stopping member **810** and generate a force thereon. The spring **816** may be selected from among multiple springs having different elastic coefficients, lengths or other properties, so as to provide force of different levels as suited or desired for different applications.

V. Fourth Example Medical Instrument

FIGS. **9**A and **9**B show a fourth example embodiment of a medical instrument **900** having a shaft **902** with a first end **904** and a second end **906**. The second end **906** includes a first stopping member **908**. The medical instrument **900** also includes a movable element **910**, a second stopping member **912**, and a locking mechanism configured to lock the movable element **910** to the shaft **902**. FIG. **9**A shows a state in which the movable element **910** is movable with respect to the shaft **902**, and FIG. **9**B shows a state in which the movable element **910** is locked with respect to the shaft **902**.

The locking mechanism can lock the movable element **910** to the shaft **902** so as to prevent movement of the movable element **910** with respect to the shaft **902**. In some embodiments, the movable element **910** may be locked to the shaft **902** during transportation so as to avoid movement of the movable element **910** that might damage the shaft **902** or other components of the medical instrument **900**, or to ease transportation and avoid undesirable noises. In other embodiments, the movable element **910** may be locked to the shaft **902** during use so that movement of the movable element **910** with respect to the shaft **902** can be substantially prevented after reduction of a fractured bone segment is performed.

As shown in FIGS. **9**A and **9**B, the locking mechanism includes a locking bolt **914** that is screwed into a threaded hole of the movable element **910**, and a locking hole **916** formed in the second end **906** of the shaft **902**. As best seen in FIG. **9**A, when the locking bolt **914** is not engaged with the locking hole **916** of the shaft **902**, the movable element **910** can move along the shaft **902**. When the movable element **910** is positioned to align the threaded hole of the movable element **910** with the locking hole **916** of the shaft **902**, the locking bolt **914** can be screwed in to engage with the locking hole **916**, so that the movable element **910** is locked in the length direction of the shaft **902**.

In FIG. **9**A, the locking bolt **914** remains in the threaded hole of the movable element **910** while the movable element **910** is free to move along the shaft **902**. In some other embodiments, the locking bolt **914** is removed from the threaded hole of the movable element **910**.

It will be appreciated, with the benefit of the present disclosure, that other locking mechanisms can be employed to lock the movable element **910** to the shaft **902**. For example, one or more screws, bolts, nuts, through holes, pins, retaining clips, straps, fasteners, or other mechanisms, used alone or in any combination, can be employed to lock the movable element **910** to the shaft **902**.

According to this and other embodiments, the movable element **910** can be used as a handle portion when it is locked with respect to the shaft **902**. Thus, the locking mechanism may facilitate convenient switching between the usage of a human hand force and a force generated by the movable element **910** on the first stopping member **908** during use of the medical instrument **900**.

In the embodiment of FIGS. **9**A and **9**B, the locking hole **916** is formed in the shaft **902** near the first stopping member **908**. In other embodiments, the locking hole **916** can be formed in other areas of the shaft **902**.

One or more of the embodiments described above with respect to FIGS. **2**A-**8**B can be combined with the embodiment of FIGS. **9**A and **9**B.

In some embodiments, to substantially prevent the locking bolt **914** from being circumferentially offset about the shaft **902** from the locking hole **916**, at least part of the shaft **902**, along which the movable element **910** is configured to move, has a non-circular cross-sectional shape, such that the movable element **910** cannot rotate about the shaft **902**. One example of a shaft **102***a* having a non-circular cross-sectional shape configured to prevent rotation of a movable element **112***a* about the shaft **102***a* is provided in FIG. **1**C.

More generally, such non-circular cross-sectional shapes for the shaft **902** may include, but are not limited to, polygonal cross-sectional shapes such as rectangles, hexagons, or trapezoids, and cross-sectional shapes that include combinations of curved and straight lines. In some embodiments, a first portion of the shaft **902** between the first and the second stopping members **908** and **912** may have a non-circular cross-sectional shape, and a second portion of the shaft **902** that extends from the second stopping member **912** to the first end **904** of the shaft **902** may have a circular cross-sectional shape.

VI. Fifth Example Medical Instrument

FIGS. **10**A and **10**B show a fifth example embodiment of a medical instrument **1000** having a shaft **1002** with a first end **1004** and a second end **1006**. The first end includes an engaging member **1008** and the second end **1006** includes a first stopping member **1010**. The shaft **1002** includes multiple sections, including a first detachable section **1012** and a second detachable section **1014**. The medical instrument **1000** also includes a movable element **1016** and a spring **1018**. FIG. **10**A shows an assembled state of the medical instrument **1000**, and FIG. **10**B shows a disassembled state of the medical instrument **1000**.

One or more of the embodiments described above with respect to FIGS. **2**A-**9**B can be combined with the embodiment of FIGS. **10**A and **10**B. Indeed, the embodiment of FIGS. **10**A and **10**B includes a first detachable section **1012** and a second detachable section **1014** that are analogous to the first detachable section **214** and second detachable section **216** of FIGS. **2**D and **2**E, while also including a removably attachable first stopping member **1010** that is analogous to the removably attachable first stopping member **502** of FIG. **5**A, and various other components disclosed with respect to some of the other Figures included herein. Components of the medical instrument **1000** of FIGS. **10**A and **10**B that are analogous to components already described above will not be described in detail below.

As shown, the first detachable section **1012** includes an end **1020** in which a plurality of retaining slots **1020***a* are formed and arranged in the length direction of the shaft **1002**. Each retaining slot **1020***a* is a recessed cavity corresponding to the shape of a flange **1022** formed at one end of the second detachable section **1014**, and can retain the flange **1022** so as to clasp the second detachable section **1014** and the first detachable section **1012** together. The attaching position of the second detachable section **1014** with respect to the first detachable section **1012** can be adjusted by relocating the flange **1022** into a different one of the retaining slots **1020***a*. Thus, the range over which the movable element **1016** is allowed to move along the shaft **1002** can be adjusted.

In this example, the first stopping member **1010** includes a main body **1010***a* and a pin **1010***b*. The second end **1006** of the shaft **1002**, that is, the end of the second detachable section **1014** that is not to be engaged with the first detachable section **1012** in this example, is formed with a plurality of pin holes **1024**. These pin holes **1024** are arranged in the length direction of the shaft **1002**. Each pin hole **1024** can receive the pin **1010***b* of the first stopping member **1010**, so as to attach the first stopping member **1010** to the second detachable section **1014** at the second end **1006** of the shaft **1002**. The attaching position of the first stopping member **1010** with respect to the shaft **1002** can be adjusted by relocating the pin **1010***b* with a different one of the pin holes **1024**.

Scale marks, such as the scale marks **218** of FIG. **2**H, may be provided on the shaft **1002**. For example, scale marks can be provided between the flange **1022** and pin holes **1024**. Thus, the range over which the movable element **1016** is allowed to move along the shaft **1002** can be adjusted with the aid of the scale marks.

The movable element **1016** is generally cylindrical in shape, and has contours **1016***a* formed on the outer circumferential surface thereof for easier manipulating of the movable element **1016** by fingers.

The spring **1018** is positioned between the end **1020** of the first detachable section **1012** and the movable element **1016**. The spring **1018** is a helical spring guided by the second detachable section **1014**. During reduction of fracture, after engaging a fractured bone segment with the engaging member **1008**, the movable element **1016** may be pushed against the spring **1018** to compress the spring **1018** against the end **1020** of the first detachable section **1012**. Then, when the movable element **1016** is released, the compressed spring expands and energizes the movable element **1016** to move toward the first stopping member **1010** and generate a force thereon.

While certain embodiments have been illustrated and described, it should be understood that changes and modifications can be made therein in accordance with ordinary skill in the art without departing from the technology in its broader aspects as defined in the following claims.

The present disclosure is not to be limited in terms of the particular embodiments described in this application, which are intended as illustrations of various aspects. Many modifications and variations can be made without departing from its spirit and scope, as will be apparent to those skilled in the art. Functionally equivalent methods and apparatuses within the scope of the disclosure, in addition to those enumerated herein, will be apparent to those skilled in the art from the foregoing descriptions. Such modifications and variations are intended to fall within the scope of the appended claims. The present disclosure is to be limited only by the terms of the appended claims, along with the full scope of equivalents to which such claims are entitled. It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to be limiting.

With respect to the use of substantially any plural and/or singular terms herein, those having skill in the art can translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity.

It will be understood by those within the art that, in general, terms used herein, and especially in the appended claims (e.g. bodies of the appended claims) are generally intended as "open" terms (e.g. the term "including" should be interpreted as "including but not limited to," the term "having" should be interpreted as "having at least," the term "includes" should be interpreted as "includes but is not limited to," etc.). It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of the introductory phrases "at least one" and "one or more" to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles "a" or "an" limits any particular claim containing such introduced claim recitation to embodiments containing only one such recitation, even when the same claim includes the introductory phrases "one or more" or "at least one" and indefinite articles such as "a" or "an" (e.g. "a" and/or "an" should be interpreted to mean "at least one" or "one or more"); the same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a specific number of an introduced claim recitation is explicitly recited, those skilled in the art will recognize that such recitation should be interpreted to mean at least the recited number (e.g. the bare recitation of "two recitations," without other modifiers, means at least two recitations, or two or more recitations). Furthermore, in those instances where a convention analogous to "at least one of A, B, and C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g. "a system having at least one of A, B, and C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). In those instances where a convention analogous to "at least one of A, B, or C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g. "a system having at least one of A, B, or C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). It will be further understood by those within the art that virtually any disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase "A or B" will be understood to include the possibilities of "A" or "B" or "A and B."

In addition, where features or aspects of the disclosure are described in terms of Markush groups, those skilled in the art will recognize that the disclosure is also thereby described in terms of any individual member or subgroup of members of the Markush group.

As will be understood by one skilled in the art, for any and all purposes, such as in terms of providing a written description, all ranges disclosed herein also encompass any and all possible subranges and combinations of subranges thereof. Any listed range can be easily recognized as sufficiently describing and enabling the same range being broken down into at least equal halves, thirds, quarters, fifths, tenths, etc. As a non-limiting example, each range discussed herein can be readily broken down into a lower third, middle third and upper third, etc. As will also be understood by one skilled in the art all language such as "up to," "at least," "greater than," "less than," and the like include the number recited and refer to ranges which can be subsequently broken down into subranges as discussed above. Finally, as will be understood by one skilled in the art, a range includes each individual member. Thus, for example, a group having 1-3 cells refers to groups having 1, 2, or 3 cells. Similarly, a group having 1-5 cells refers to groups having 1, 2, 3, 4, or 5 cells, and so forth.

From the foregoing, it will be appreciated that various embodiments of the present disclosure have been described herein for purposes of illustration, and that various modifications may be made without departing from the scope and spirit of the present disclosure. Accordingly, the various embodiments disclosed herein are not intended to be limiting, with the true scope and spirit being indicated by the following claims.

The invention claimed is:

1. A medical instrument, comprising:

a shaft including:

a first elongated section including an engaging member at a first end of the first elongated section and an aperture in a second end of the first elongated section that is opposite the first end of the first elongated section, the aperture including internal threading and the engaging member comprising a hook; and

a second elongated section including a stopping member at a first end of the second elongated section and external threading at a second end of the second elongated section that is opposite the first end of the second elongated section, the stopping member having a diameter greater than a diameter of a body of the second elongated section that extends between the external threading and the stopping member;

a movable element separate from the shaft, the movable element having a through-hole therein, the through-hole sized and configured to enable movement of the movable element along the body of the second elongated section of the shaft, wherein a length of the body of the second elongated section along which the movable element moves is adjusted by varying a depth by which the external threading at the second end of the second elongated section is engaged with the internal threading of the aperture in the second end of the first elongated section; and

a locking mechanism configured to secure the movable element to the shaft, the locking mechanism includes:

a locking bolt configured to engage a threaded hole extending through the movable element in a direction substantially perpendicular to a longitudinal axis of the shaft; and

a locking hole formed in the shaft, the locking hole sized and configured to substantially align with the threaded hole such that the locking bolt is positioned to extend through the threaded hole into the locking hole.

2. The medical instrument of claim **1**, wherein the hook has a circular, a rectangular, or a flat-plate configuration.

3. The medical instrument of claim **1**, wherein the internal threading in the aperture in the second end of the first elongated section corresponds to the external threading on an external surface of the second end of the second elongated section to enable the second ends of the first and second elongated sections to be removably attached to each other.

4. The medical instrument of claim **3**, wherein the shaft is adjustable in length by varying a depth at which the external threading is engaged with the internal threading.

5. The medical instrument of claim **1**, wherein the stopping member comprises a first stopping member, and wherein the aperture is formed in a second stopping member of the second end of the first elongated section, the second stopping member being integral with the first elongated section and having a diameter greater than that of the through-hole in the movable element to confine the movable element between the first stopping member and the second stopping member along the shaft.

6. The medical instrument of claim **5**, further comprising a spring positioned around the body of the second elongated section of the shaft between the second stopping member and the movable element.

7. The medical instrument of claim **6**, wherein the spring is sized and configured to be compressed against the second stopping member at the second end of the first elongated section to enable the spring to generate a force on the movable element in a direction of the first stopping member.

8. The medical instrument of claim **1**, wherein the movable element includes contours formed on an outer surface of the movable element.

9. The medical instrument of claim **1**, wherein a cross-sectional shape of the through-hole and a cross-sectional shape of at least a portion of the second elongated section are non-circular.

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